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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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MINERAL SCIENCES DIVISION

INTERNAL REPORT MS-65-51

REPORT ON THE 1965 INTERNATIONAL CONFERENCE ON MODERN TRENDS IN ACTIVATION ANALYSIS, COLLEGE STATION, TEXAS, AND OF A VISIT TO THE DEPARTMENT OF NUCLEAR ENGINEERING, GEORGIA INSTITUTE OF TECHNOLOGY, ATLANTA, GEORGIA, APRIL 19 - 24, 1965

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H.P. Dibbs

June 15, 1965

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The 1965 International Conference on Modern Trends in Activation Analysis, held at the Texas A and M University, College Station, Texas, was attended from April 19-22, 1965. The meeting was sponsored by the International Atomic Energy Agency, the European Atomic Energy Community, the United States Atomic Energy Commission, and the host college. Approximately 500 delegates, from 27 countries, were present; a fact that reflects the widespread interest in this specialised analytical method.

This meeting was the second international conference to be devoted exclusively to activation analysis; an earlier meeting was held in 1961 (also at Texas A and M). As with the previous meeting, the main emphasis was on neutron activation analysis. However, on this occasion more interest was evident on the application of charged particle and photon

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activation for cases where neutron activation was impossible or subject to interference and sensitivity limitations. Engleman et al. of the French A.E.C. reported on the use of a 40 MeV linear electron accelerator, a 44 MeV cyclotron for accelerating alpha particles, and a variable energy (3-30 MeV) proton accelerator for the rapid, nondestructive analysis of nonmetallic impurities in nuclear-grade metals. The determination of oxygen, carbon, nitrogen and fluorine are made routinely in the range of 10^{-7} g or better. A convincing case for a small 10 MeV cyclotron in activation analysis was proposed by Ricci et al. (O.R.N.L.). With a beam current of 100 microamperes such a machine could determine oxygen at the 2×10^{-10} g level, by accelerating helium-3 ions, through the reaction O16 (He3, α) O15. A large number of other elements may also be determined, although the limited range of positive ions restricts the method to thin samples. Bombardment of a beryllium target with helium ions gives rise to a high-intensity neutron source, with a yield (2×10^{11}n/sec) comparable to that available from a neutron generator, but without the problems of target deterioration, that are associated with a generator. The use of a beryllium target also provides a profilic source of 20 MeV gamma radiation for use in photon activation. An advantage existing with a cyclotron would be the possibility of varying the alpha-particle energy and hence, also, the energy of the neutrons and photons produced from a suitable target. An approach to variable-energy neutron-activation analysis was discussed by Steele (General Atomic). A 3 MeV Cockcroft-Walton accelerator was used to accelerate a positive-ion beam and to bombard a

neutron-producing target. By varying the type of positive-ion, the accelerating voltage, and the target, approximately mono-energetic neutrons with energies from a few keV to 20 MeV may be produced. Advantage can thus be taken of resonances in the cross section – energy curve for various elements, to optimise formation of the isotope of interest. It is also possible with this technique to avoid the formation of unwanted isotopes, produced in fast neutron activation, by maintaining the neutron energy below the threshold value for an interfering reaction. Thus fluorine may be determined in the presence of oxygen (by the F 19 (n, α) N 16 reaction) without interference from the O16 (np) N 16 reaction, by the use of neutrons of energy less than the O16 (np) threshold of 9.6 MeV.

In the neutron generator field, the development of sealed-tube sources appears to be very promising (Bouden et al., Services Electronics Research Laboratory, Britain). The neutron-producing tube is only 6 in in diameter and 42 in long. A continuous, steady output of 10^{10} n/sec for 100 hrs has been achieved. Further developments are expected to give an order of magnitude improvement in neutron output and increased operational life. One advantage of such a source is the relative ease of neutron shielding. Shielding can be achieved by lowering the tube into a 10 ft deep hole, the free space being occupied by polyethylene chips. A neutron generator has been in operation for almost a year for the automatic on-line analysis of oxygen in steel (Gray et al., Plessey - U.K., Ltd.). It was found that errors that appeared in some results could be traced to poor sampling techniques, rather than to errors in the equipment. Results were

obtained very quickly (a few minutes after sampling) and about 600 samples per day were processed. Another in-plant application of generators was also reported for the analysis of coal for carbon, oxygen, silicon and aluminium. Fast neutron inelastic scattering was used for carbon and oxygen determinations, and activation analysis to measure the silicon and aluminium contents. Feasibility studies have shown that the calorific value of coal can be determined fairly accurately by the carbon content and the ash content may be related to the amount of aluminium and silicon.

A number of other fairly specific applications of activation analysis were also covered, e.g., forensic applications to hair analysis and gun-shot residues, biological applications, and metallurgical analysis. The general impression gained at this conference was that the range and applications of activation analysis are now widely appreciated and that activation analysis, although a very powerful technique, is certainly not the best method for every situation. The complete proceedings of this meeting will be published later, and without doubt, will provide an excellent account of the current status of activation techniques.

Following the conference a visit was made to the Department of Nuclear Engineering, Georgia Institute of Technology, Atlanta. A 5-megawatt heavy water cooled and moderated reactor is currently undergoing low power testing. When fully operational, a thermal neutron flux of about 10^{14} n/cm^2/sec will be available for activation analysis and other experiments. A special bio-medical irradiation facility is also built onto one face of the reactor shield. Other facilities associated with the reactor

are two, 50,000-curie hot cells and a gamma irradiation area (10^6 R/hr) using spent fuel rods. A neutron generator is currently occupying one of the hot cells. Other special equipment available in the radiochemical field are a 12,000-curie Cs-137 source and a 1-MeV Van de Graaf accelerator.

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